MTA Fleet **FM** Management

Fixed-Route Core-Bus System

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B.1 INTRODUCTION

This documents serves as the Fleet Management Plan for the Maryland Department of Transportation, Mass Transit Administration's (MTA) bus system. The purpose of the plan is to document existing operations and maintenance procedures and determine how effectively the bus system's supply of vehicles is being utilized to accommodate current and anticipated future levels of ridership demand for the system.

The Fleet Management Plan is especially valuable to both the MTA and the Federal Transit Administration (FTA) in understanding the proportion of the bus fleet that must be maintained as spares in order to preserve the system's service structure. Managing fleet size in relation to service levels is smart management and is also fiscally responsible. The FTA guideline of maintaining a 20 percent spare ratio is used by transit agencies as a key indicator of system performance.

Specific guidance for creating the MTA Bus System Fleet Management Plan was taken from a February 8, 1997 memo from Hiram J. Walker, Associate Administrator for FTA Program Management as well as the work completed on the Fleet Management Plans for the fleets of the MTA's Central Light Rail, MARC Commuter Rail, and Metro Rapid Rail systems.

B.2 DOCUMENT ORGANIZATION

The MTA Bus System's Fleet Management Plan is organized as follows:
- Overview of the MTA Bus System
- Analysis of passenger and fleet demands
- Analysis of vehicle maintenance requirements
- Analysis of revenue vehicle supply
- Comparison of revenue vehicle supply and demand

B.3 OVERVIEW: MTA BUS SYSTEM

B.3.1 GENERAL SYSTEM INFORMATION

The MTA provides statewide public transportation services through an integrated network of directly operated and privately contracted buses; Metro heavy rail, Light Rail, and Maryland Rail Commuter (MARC) train services; and Paratransit services. The bus service is the largest component of the MTA's operations; buses operated well over 85 percent of the trips in 1998. Each of the elements of the bus system is outlined below.

1. Core Bus - The 'core' bus system provides service focused on the Baltimore region, more specifically Baltimore City, Baltimore County and Anne Arundel County. The route network is comprised predominantly of former streetcar routes in Baltimore City and the close-in suburbs that were taken over from private operators as well as smaller private bus providers in Anne Arundel and Baltimore Counties. Many of the routes, especially in the city, are unchanged from the original streetcar alignments, while others have been adjusted to take into account land use changes and new regional development patterns. In addition, significant changes were implemented when many of the system's routes were transformed during the 1980s to become feeder routes into the Baltimore Metro and the Central Light Rail Line.

Currently the core system is comprised of 48 routes that typically provide service between 5:00 am and 1:00 am, though eight of the heavy haul routes operate 24 hours a day. Service is primarily radial with routes connecting downtown Baltimore and outlying neighborhoods. However, several routes serve as rail feeders and crosstown routes.

Model	Year[1]	Maintenance Facility Divisions				Total Buses	Capacity (Passengers)	Total Capacity
		Bush	Eastern	Kirk	Northwestern			
ETRO 40'	1985	23	13	7	5	48	43 Seated + 35 standees	78
ETRO 40'	1986	1	26	28	17	72	43 Seated + 35 standees	78
ETRO 40'	1987	53	10	19	14	96	43 Seated + 35 standees	78
ETRO 30'	1987	4	4	2	5	15	35 Seated + 29 Standees	64
ETRO 40'	1988	25	10	27	18	80	43 Seated + 35 standees	78
ETRO 40'	1989	14	14	24	28	80	43 Seated + 35 standees	78
ETRO 40'	1990	22	18	22	20	82	43 Seated + 35 standees	78
ETRO 40'	1992	14	10	15	11	50	43 Seated + 35 standees	78
ETRO 40'	1994	15	8	10	0	33	43 Seated + 35 standees	78
rticulated	1995	0	0	0	10	10	62 Seated + 55 standees	117
ETRO 40'	1995	5	4	5	5	19	43 Seated + 35 standees	78
rticulated	1997	15	0	0	5	20	62 Seated + 55 standees	117
ETRO 40'	1997	3	17	18	12	50	43 Seated + 35 standees	78
ETRO 40'	1998	17	16	16	16	65	43 Seated + 35 standees	78
ETRO 40'	1999	20	14	18	15	67	43 Seated + 35 standees	78
Total		231	164	209	181	787	43 Seated + 35 standees	78
verage Fleet Age: 9.1 Years					Average Capacity: 79 passengers			

Table B-1: Current Fleet Size and Composition by Maintenance Facility, 1999

Service is provided from four bus divisions located throughout Baltimore City. These divisions include bus storage yards, maintenance facilities, and bus dispatching operations.

2. Commuter Bus - The MTA operates two separate peak period commuter bus systems, one focused on service in the Baltimore region and one focused on service to Washington D.C.

There are ten commuter lines providing service in the Baltimore region, with four of these directly operated by the MTA and six operated by contract operators. These routes provide service from suburban residential areas throughout the Baltimore region to downtown Baltimore as well as reverse commute trips from the city to suburban office centers. These Baltimore area commuter routes carry an average of 2,209 riders per day, based on 1998 on-

board counts. The MTA operated services are provided from the MTA bus divisions also utilized for core bus operations.

The MTA provides eight privately contracted commuter bus services which offer long-haul service from points throughout Maryland to Washington, D.C. and its inner-ring suburbs. Based on 1998 on-board ridership counts, these commuter routes carry approximately 4,402 riders on an average weekday.

3. Paratransit - The MTA's Paratransit service is a demand responsive service provided in the Baltimore region for individuals with disabilities who are unable to use regular MTA bus service. This service carries 1,456 passengers on an average day, using a fleet of 20 vans as well as contracted, subsidized taxis and vans.

B.3.2 EXISTING FLEET

The MTA has an existing fleet of 787 vehicles of which 509 vehicles (64.7 percent) are equipped with wheelchair lifts. This fleet is wholly comprised of traditional diesel powered buses. Buses are dispatched from four divisions in Baltimore City - Bush, Eastern, Kirk and Northwestern. The vehicle fleet includes 742, 40-foot buses with a capacity of 43 seated and 35 standing passengers, 30, 60-foot, articulated buses with a capacity of 55 standing and 62 seated passengers and 15, 30-foot buses as shown in Table B-1. The majority of the articulated buses operate on the 2 and 91 routes.

B.3.3 CURRENT BUS OPERATIONS

Table B-2 summarizes existing core-bus system service characteristics. During a typical weekday, 243,413 trips are made aboard the MTA bus network. Each bus operates an average of 27,173 miles annually including 3,997 deadhead miles. Figures B-1 and B-2 show the trends in annual revenue vehicle miles and annual revenue vehicle hours for the bus system from 1992 to 1999. From 1992 to 1999 both annual revenue vehicle miles as well as annual revenue vehicle hours have decreased significantly. The annual revenue miles decreased from 19.88 million to 18.23 million miles from 1992 to 1999 while during the same period the annual revenue vehicle hours decreased from 1.78 million to 1.61 million hours. This was because of bus service cutbacks instituted in 1992-93. A key parameter used in service planning and fleet deployment is the state-mandated farebox recovery ratio. The bus service is currently required to maintain a 40 percent recovery ratio. In 1998, average weekday service had a farebox recovery of 58.14 percent.

	Weekday	Saturday	Sunday
Ridership – Total	243,413	123,207	56,009
AM Peak Pull Out	649	160	96
PM Peak Pull Out	656	160	96
Base Service Pull Out	263	180	100
Trips per Day	5,713	3,274	1,937
Vehicle Miles	71,603	37,274	24,145
Vehicle Hours	5995	3106	1956
Revenue Vehicle Miles	61,579	35,038	22,938
Revenue Vehicle Hours	4,796	2,609	1,604
Boardings/Mile	3.56	3.32	2.53
Boardings/Trip	43.83	37.57	31.31
Subsidy/Boarding ($)	0.57	0.55	1.01
Farebox Recovery (%)	58.14	60.67	45.86

Source: Transit Route Profiles 1998, MTA, October 1999

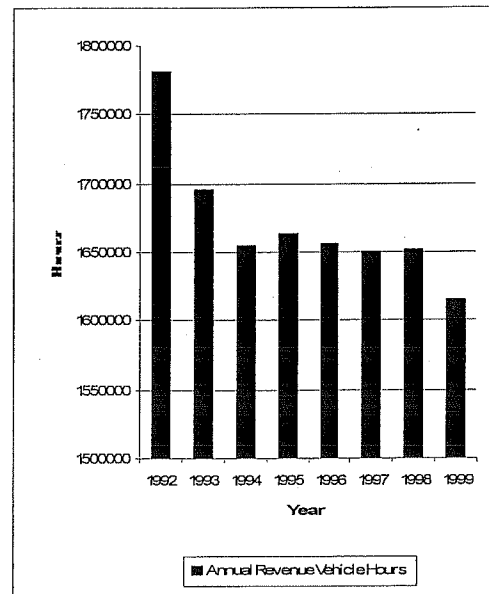Table B-2: Existing Core-Bus Service Characteristics

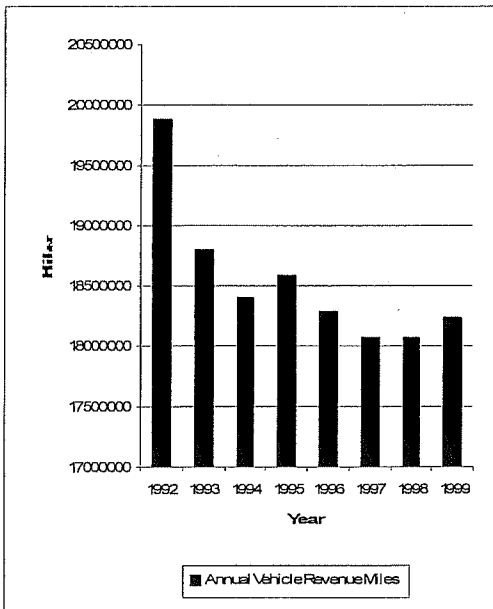Figure B-1 : Trends in Annual Revenue Vehicle Miles

Figure B-2 : Trends in Annual Revenue Vehicle Hours

B.4 REVENUE VEHICLE DEMAND

B.4.1 RIDERSHIP TRENDS

Ridership on the MTA bus system has generally remained stable and as a result the network's service structure has not changed dramatically. Discussions with the MTA indicate that new plans are being developed to design new routes and expand service into areas which currently have no or minimal service. The plans aim to achieve a 16,000 increase in average weekday ridership over a five-year period. However, the plans are still at the formulation stage and additional vehicle requirements cannot be estimated at this stage. The fleet management plan will therefore, have to be revised at a later date when these plans are finalized and implemented.

Figure B-3 illustrates the average weekday ridership trend between 1994 and 1998. The core-bus routes carried an average of 243,413 unlinked passengers on a typical weekday in 1998. This was a decrease of 0.2 percent from

1997. Saturday ridership was 123,207 in 1998, an increase of 1.1 percent over the previous year while Sunday ridership was 56,009, a decrease of 4.5 percent. The core-bus ridership has stabilized in 1998 over the previous year after declining for several years prior to that. It should be noted that the average weekday ridership figure does not reflect the additional daily ridership created by special events such as ball games, celebrations at the Inner Harbor, events at the Convention Center, and events at the Arena.
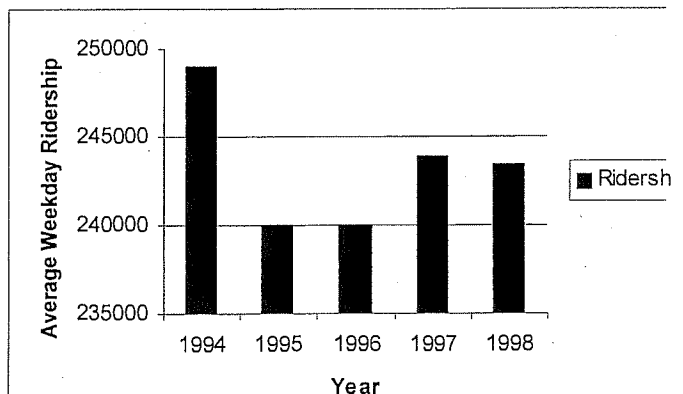
Source : Transit Route Profiles 1998, MTA, October, 1999 - On-board Electronic Farebox Counts

Figure B-3: Average Weekday Ridership Trend

B.4.2 VEHICLE REQUIREMENTS

B.4.2.1 Peak and Off-Peak Vehicle Requirements

The MTA has calculated its total weekday core-bus peak vehicle requirements based on the headways of individual routes and layover/deadheading hours. The peak vehicle requirement is 656 buses, which represents the number of buses required for the PM peak pullout. The AM peak pullout is 649 buses while 263 buses are required for off-peak service. In the off-peak hours and on weekends, headways are greater compared to the peak hour headways on most routes. Moreover, on

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	Weekdays	Saturdays	Sundays
Peak Bus Requirements	656	160	96
% of Total Fleet	83%	20%	12%
Off-Peak Bus Requirements	263	180	100
% of Total Fleet	33%	23%	13%

Table B-3: Peak and Off-Peak Vehicle Requirements

weekends the service hours are also restricted. Thus, the vehicle requirements during midday and weekend service are lower than peak requirements as illustrated in Table B-3. Saturday and Sunday off-peak vehicle pull-outs are greater than weekday base service pull-out since most of the non-work based trips, such as shopping, take place on weekends during non-peak hours, e.g., afternoon.

B.4.2.2 Special Event Requirements

The bus network connectivity makes it well suited to serving numerous special events throughout the region, the most frequent of which are the 81 regularly scheduled baseball games of the Orioles. Other events include:

- Ravens football games
- New Year's eve
- Maryland State Fair
- Baltimore Artscape
- Fourth of July
- Arena events
- Conventions
- Circus
- Concerts at the Inner Harbor
- Additional events at PSINet Stadium

In all, MTA spends about one-third of the calendar year providing service to special events. Service and vehicle requirements vary by event.

Football games Because football crowds tend to exit all at once rather than trickling out during the last half of the game, Ravens games generate the greatest load factors faced by buses. The MTA operates an additional 85-100 buses to meet the requirements of the Ravens games.

Baseball games Baseball games also generate significant load factors. However, since crowds tend to filter out during the last innings of a game, the peak demands are relatively less than those of football games. The MTA operates an additional 25 coaches to meet the demand generated by baseball games.

Other Special Events For other special events, additional coaches are operated as and when necessary.

Since the majority of the football games and most other special events occur on weekends or at non-peak times, when vehicle requirements are lower compared to peak operations, the current fleet size is sufficient to meet the transportation service requirements generated by these special events. Buses for evening special events, such as night ball games, however, have to be available for deployment to their departure locations up to three hours prior to event time, thus overlapping with evening peak service. Thus, the MTA has difficulty in meeting the MTA core-bus system requirements when any of the special events coincide with peak period operations.

B.4.3 PEAK VEHICLE DEMAND

Because the majority of transit boardings throughout the year occur during the morning and evening rush hours, it is necessary to determine if the existing service schedule provided by the bus system is sufficient to accommodate

peak ridership demands. As detailed on-off counts for peak hour ridership for 1998 by route are not available, the following methodology was used to estimate individual route peak vehicle requirements:

Step 1- Calculate Peak Load Factors The peak load factor represents the point on a route where the heaviest passenger load on a bus, during the entire day, occurs. Each route in the bus system will have its own maximum load point. This peak load point, in conjunction with vehicle capacity and load standards, determines the required service frequency and thus, also the total number of buses that must be in service to provide sufficient vehicle capacity to meet peak passenger demand on each route.

Because the MTA does not have detailed ridership data by trip, peaking factors are used here to estimate peak load boardings. Based on experience in Baltimore as well in similar cities in the United States, it is estimated that 8 percent of total daily weekday boardings occur in the peak hour. Further factoring this number for the purpose of determining vehicle requirements, it is estimated that 33 percent of the peak hour boardings occur in the peak 15 minutes of the peak hour.

Because some passengers who board during the peak 15 minutes alight before the bus reaches its peak load point (i.e. in a trip toward downtown in the morning peak), it is estimated that 90 percent of peak 15-minute loadings will be on the bus at the peak load point.

Step 2- Calculate Vehicle Capacity Current Operations Currently, buses on different routes in the bus network operate with different headways. Routes 2 and 91 are served by articulated buses only during weekdays; all other buses are dispatched as scheduled without being route

specific. Based on the existing configuration of bus vehicles, each 40-foot regular bus has a capacity of approximately 78 passengers(comfortable standing load – 43 seated, 35 standing). To estimate each route's total vehicle capacity, the number of buses available in the peak 15 minutes on each route were computed based on their frequency.

Step 3- Peak Load Factors vs. Vehicle Capacity Since the vehicle capacity and peak load factors have been estimated for the core-bus system on a route by route basis, a comparison of peak load point vs. vehicle capacity during the peak 15 minutes has also been evaluated for each route. Figure B-4 shows that on 73 percent of the system routes, available vehicle capacity exceeds demand during the peak of the peak. The maximum underutilization of capacity occurs on Route 6 and Route 86 which have been designated as "problem" routes according to the MTA 1998 "Transit Route Profiles" report.

Conversely, on some routes, ridership exceeds the capacity; routes 23, 8, 15, 20 and 13 have significant overloading resulting in 58.5 percent to 176 percent capacity overruns. This is primarily because these routes are either cross-town which connect two points without entering downtown Baltimore or radial through-routes which operate between any two points via downtown Baltimore. Therefore, these routes carry passengers much beyond the downtown region and have a greater number of boardings.

Thus, while a system level analysis indicates that the existing fleet size can accommodate the current demand, some routes experience overcrowding and may need additional vehicles for revenue service. However, two additional points should be taken into account:

1. These calculations do not take into account the impact of wheelchairs. 65 percent of buses are capable of accommodating passengers in wheel chairs. However, the areas designated for wheelchair travelers require three seats to be folded up. This impacts the total capacity of a bus.

2. These calculations are based on average weekday ridership counts and do not take into account the additional demands of special events coinciding with peak hour, peak direction travel. In such cases, existing buses may be required to operate at crush capacity.

B.4.4 Future Vehicle Demand: Ridership Estimates

A key component of fleet management is determining whether the existing fleet is sufficient to handle future levels of ridership. As discussed, the ridership trends indicate that ridership has stabilized over the past few years with little variation in the network's service structure. Plans aimed at increasing the average weekday ridership by 16,000 passengers by expanding service into areas currently not served, are under formulation at the MTA. Proposals include enhancement of existing routes to serve more locations or to operate longer hours or more days; splitting of existing routes into more than one route; and new services such as neighborhood shuttles and community routes.

Based on these estimates, the existing fleet needs to be expanded to accommodate the future demand. Detailed fleet requirement estimations, however, can only be done once the plans are finalized and implemented. Moreover, certain existing routes may require additional vehicles to be deployed for meeting peak requirements. Also, as vehicles approach the end of their useful life, they would need to be replaced with new vehicles to maintain service levels.

B.5 VEHICLE MAINTENANCE REQUIREMENTS

Proper fleet management requires a basic understanding of the effects of maintenance schedules on vehicle availability. The following is a summary of bus maintenance practices.

B.5.1 Maintenance Cycles
The MTA maintains a regular program consisting of several levels of inspection and maintenance on buses and their components, based on time and mileage. Table B-4 summarizes the maintenance schedule for buses. The MTA essentially carries out five types of inspections on buses. The oil change and grease jobs are carried out every 2500 gallons of fuel consumed by a vehicle while the brake inspection and major inspection are carried out every 3000 and 9000 miles respectively. A major inspection involves checking all of bus' systems such as electrical, mechanical, air-conditioning, parts and components. Typically a major inspection requires eight labor hours; however, this may extend to 16 hours depending on vehicle conditions. The other two types of inspection are the air-conditioning system inspection and the wheelchair lift inspection. The MTA does not have a mid-life overhaul program for the bus system.

B.5.2 Maintenance Facilities and Labor

Cleaning, fuelling and daily inspections of the bus fleet are carried out at four divisions in Baltimore city - Bush, Eastern, Kirk and Northwestern. The engine overhauls are carried out in the Main Shop while all the bodywork is inspected at the MTA's Body Shop. MTA also
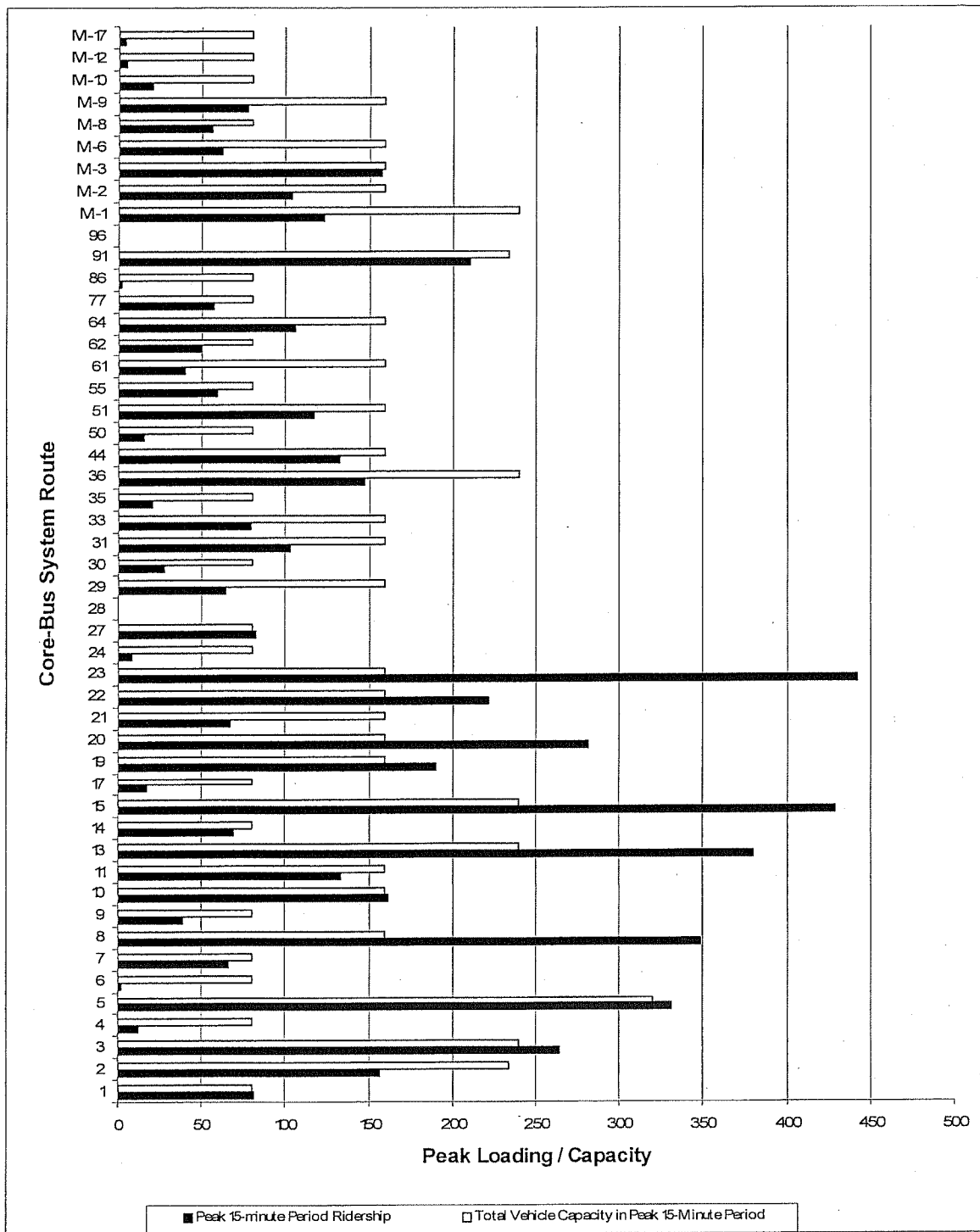
Figure B-4: Passenger Loading at Peak Load Point vs. Vehicle Capacity on Core-Bus System

Inspection	Criterion	Labor Hours	Work Description
Weekly / Monthly Inspection	Every 2500 gallons of fuel used	1 hour	Oil change and grease job is carried out.
Brake Inspection	Every 3000 miles of operation	1 hour	The Brake system of buses is examined.
Major Inspection	Every 9000 miles of operation	8 hours	All vehicle components and systems are inspected for defects.
HVAC Inspection	Every 120 days	6 hours	The HVAC system is checked for defects.
Wheelchair Lift Inspection	Every 90 days	4 hours	The wheelchair lifts are inspected.

Table B-4: Bus Fleet Maintenance Cycles

Maintenance Division	Age in Years		Number of Buses				Maintenance Personnel			
	Main Shop	Wash-house	40'	30'	60'	Total	Mechanics	Other Staff	Total	Staff/Bus
Bush	91	25	212	4	15	231	48	24	72	0.31
Eastern	56	22	160	4	0	164	35	20	55	0.33
Kirk	56	22	207	2	0	209	40	23	63	0.30
Northwestern	13	13	163	5	15	183	41	21	62	0.34

Table B-5: Maintenance Division Capacity and Staffing

has an AC Shop where major air conditioning system overhauls are carried out. Articulated buses can be serviced at any of the four divisions; however, they are typically serviced at the Bush and Northwestern divisions. The existing facilities operate with some constraints of space, especially at Kirk and Eastern, age and staffing levels. Table B-4 shows the current fleet distribution by each maintenance division and the number of maintenance personnel at each facility. The maintenance staff works four shifts daily; these shifts are from 8:00 am – 4:30 pm, 4:00 pm – 12:30 am, 6:30 pm – 3:00 am and 12 am – 8:30 am

B.5.3   MAINTENANCE DEMAND

B.5.3.1 Routine Scheduled Maintenance Demand

The impacts of routine, scheduled maintenance on the daily availability of buses are displayed in Table B-5. The calculations used to derive these estimates are included in Appendix A. Table B-5 indicates that about 20 vehicles per day are pulled in for Brake Inspection while seven vehicles are pulled in for a major inspection. (Note that it takes approximately 8-16 hours to perform a major inspection on one bus). The table does not include the daily demand for vehicles scheduled for oil change and grease jobs. In addition to these, all vehicles are pulled in daily for refueling and cleaning which is

Inspection	Frequency per year	Daily demand	Labor Hours / Inspection	Labor Hours Required
Brake Inspection	7294.1	20	1	20
Major inspection	2431.4	7	8	56
HVAC inspection	2698.0	7	6	42
Wheelchair Lift inspection	3597.3	9	4	36
Total Daily Demand		43		154

Table B-6: Average Daily Demand for the Bus Fleet: Regular Maintenance
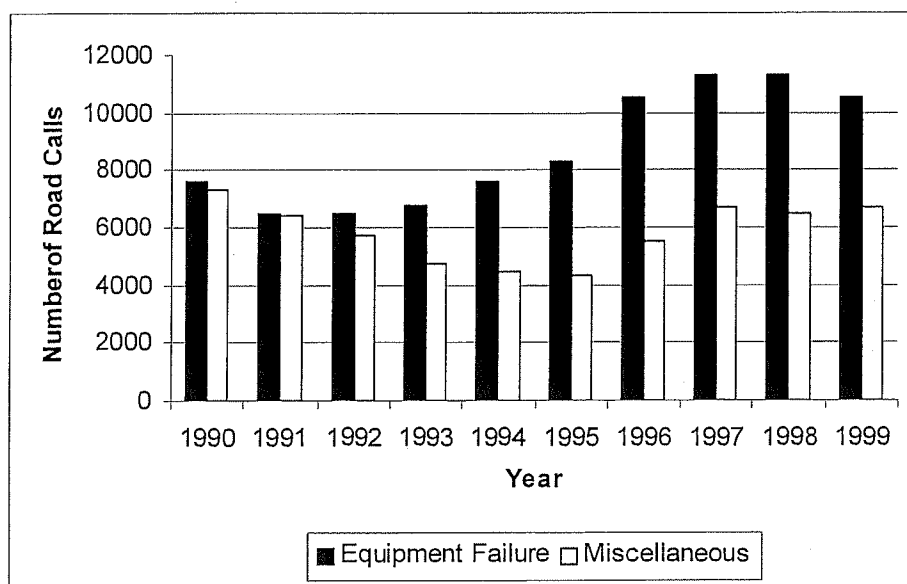

Figure B-5: Annual Summary of Service Calls Due to Equipment Failure and Other Reasons

included as part of scheduled maintenance procedures. Overall, on an average, about 105 buses are pulled in for scheduled maintenance daily.

The scheduled maintenance is done at the discretion of bus superintendents and approximately 60 percent of it is done during the two night shifts. Thus, the remaining 40 percent of scheduled maintenance is performed during regular hours of revenue service and therefore, impacts the availability of vehicles for revenue operations.

B.5.3.2 Unscheduled Maintenance History
The majority of fixed-route bus maintenance

demands are imposed by unscheduled and corrective maintenance. Vehicles are pulled in for unscheduled maintenance under two categories:

1. Equipment Failure- This refers to defects in the axles, body, doors, brakes (mechanical, electrical and air), lighting system, cooling system, engine, heating system, air conditioning system, wheelchair lifts, wipers, steering and other vehicle components .
2. Miscellaneous Reasons- Other reasons for a vehicle to be pulled in for unscheduled maintenance include flat tires, broken glass, graffiti removal, vandalism, and accidents. In 1998,

there were 1,269 bus traffic accidents, a rate of 5.29 accidents per 100,000 miles of service. Such accidents have resulted in both major and minor collision damages to the vehicles requiring immediate repairs.

One measure of vehicle reliability is the number of road calls during revenue service requiring vehicles to be pulled in during a trip. According to Figure B-5, the number of road calls for unscheduled maintenance have increased substantially over the past 9 years. The increase has been mostly due to rise in equipment failure rates. The number of service calls due to equipment failure were 7,584 in 1990 and have increased to 10,501 service calls in 1999.

On an average, about 250 buses are pulled in for unscheduled maintenance daily. Thus, between scheduled and unscheduled maintenance requirements, up to 355 buses may be pulled in for shop work over a 24-hour period.

B.5.4   Factors Affecting Maintenance Demand

Several factors have contributed to the low vehicle reliability (in terms of increasing number of service road calls) and high scheduled and unscheduled maintenance requirements of the MTA bus system. These are outlined below.

B.5.4.1 Age of Fleet

Figure B-6 shows the average bus fleet age from 1990 to 1999. The average age of the bus fleet has risen from 8.1 years in 1995 to 9.1 years in 1999. Because about 30 percent of the fleet is more than twelve years old, the optimal life of a bus, more serious defects are found during scheduled and unscheduled inspections resulting in higher maintenance demands than previously experienced by the fleet.
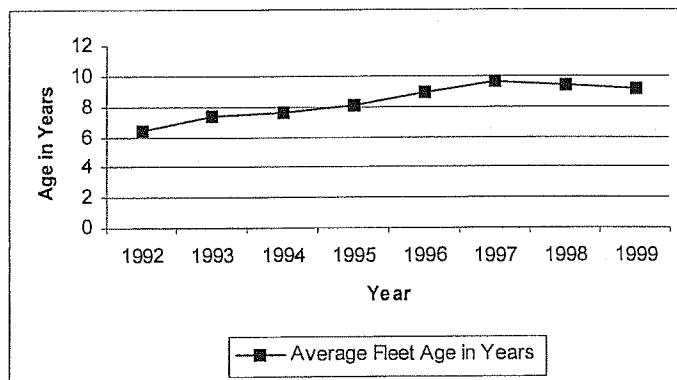

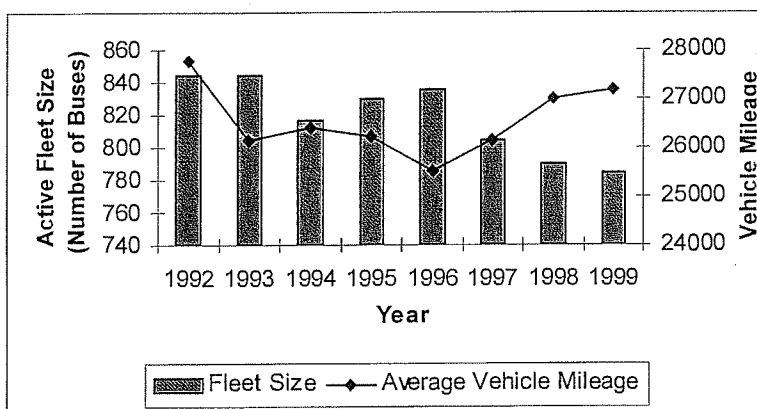Figure B-6: Trends in Average Bus Fleet Age

Figure B-7: Trends in Average Vehicle Mileage

B.5.4.2 Bus Mileage

Adding to the unscheduled demand is the additional bus mileage; under the existing service structure, each bus is averaging 27,173 miles a year. This is an increase of 6 percent since 1996 as shown in Figure B-7. This additional vehicle mileage translates into the increased "wear and tear" of certain components resulting in high maintenance demand.

B.5.4.3 Maintenance Capacity

As discussed, the four maintenance facilities function with some location and space con-
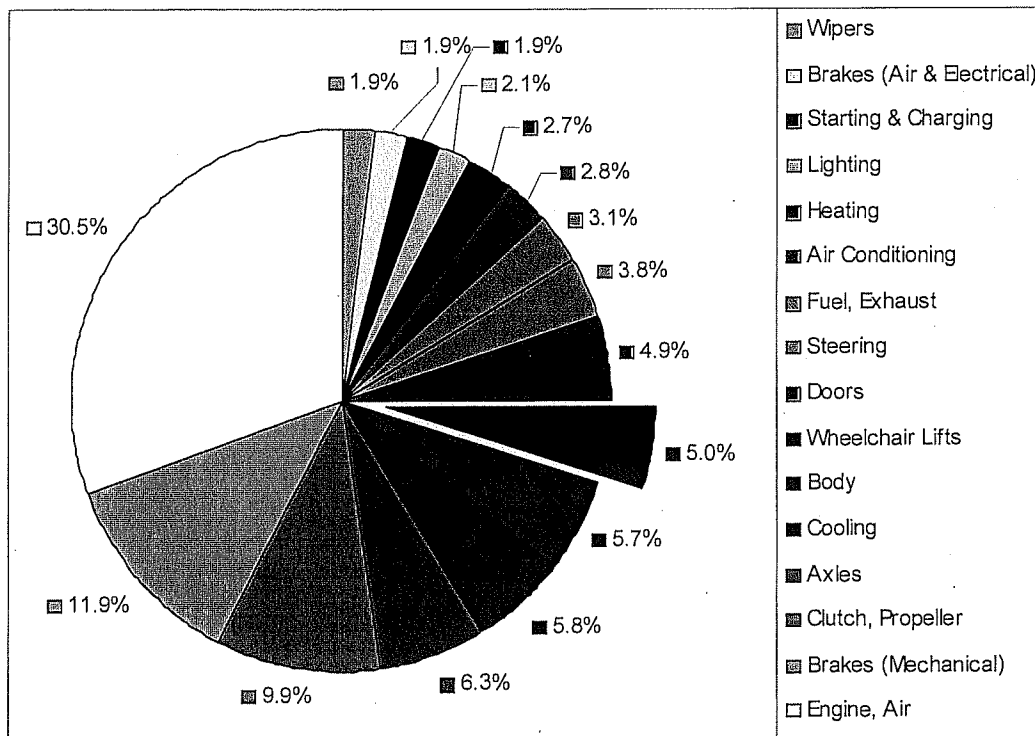
Figure B-8: 1999 Road Call Summary Due to Wheelchair Lift and Other Equipment Failure

straints, especially Eastern and Kirk. This places a constraint on the ability to process the necessary maintenance work load. Moreover, the bus maintenance staff was reduced by 32 in 1993 as part of budgetary cuts. These 32 positions have not been regained, resulting in increased work load for each of the maintenance personnel and an increase in maintenance labor hours.

B.5.4.4 Extra Maintenance Requirements

Currently, about 65 percent of the core-bus system fleet is wheelchair lift equipped. Wheelchair lift inspections typically require 4 labor hours and are highly labor intensive. Wheelchair lift malfunctioning was responsible for 5 percent of the total equipment-failure service calls in 1999 as displayed in Figure B-8. Wheelchair lifts have, therefore, increased main-

tenance hours appreciably.

Discussions with the MTA indicate that there are no current plans for new maintenance facilities, for alternative-fuel buses, or for a vehicle mid-life overhaul program. MTA plans to purchase 80 buses per year for the next five years. This may result in a drop in failure rates and a corresponding increase in fleet reliability and availability, possibly allowing fewer buses to be required for the same level of service.

B.6   REVENUE VEHICLE SUPPLY

The supply of vehicles available for revenue operations is affected by three factors: vehicle retirements, vehicle procurements and vehicle operations and maintenance.
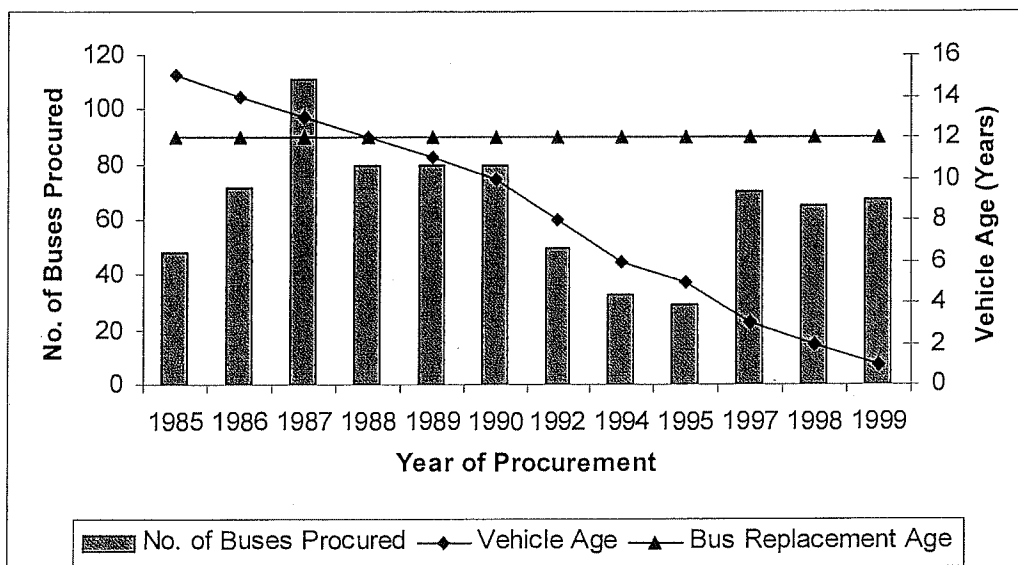
Figure B-9: Existing Bus Fleet - Scheduled Retirements

B.6.1 RETIREMENT

Figure B-9 illustrates that the oldest buses currently in revenue service were purchased in 1985. The figure also indicates the age of each batch of vehicles as of year 2000. 48 vehicles procured in 1985 will complete 15 years in revenue service in 2000 while 72 vehicles purchased the following year will be in service for 14 years in 2000. Assuming an optimal 12-year life for each bus, 231 buses (29.4% of the total fleet) currently in operation, should have been replaced by 2000. Another 80 buses (10.8% of the total fleet) need to be retired in 2000.

B.6.2 PROCUREMENT

As part of the ongoing Six-Year Bus Plan, the MTA will be procuring an additional 80 vehicles each year for the next five years solely for replacing buses being retired. Thus, the new procurements will not increase the total number of vehicles available for operations and maintenance. Figure B-9 shows the scheduled procurement of buses over the next five years.

B.6.3 VEHICLE DEMAND

Comparing cumulative vehicle retirement requirements and cumulative vehicle supply over the next five years through 2004, it is evident that the MTA will be unable to replace its aging fleet completely based on the existing replacement schedule as shown in Figure B-10. Therefore, some existing groups of buses will of necessity be kept in service longer than the optimal 12 years, if procurements occur at the existing rate. With a fixed acquisition rate for revenue vehicles over the next five years and 30 percent of the existing fleet scheduled to retire in the immediate future, the greatest factor affecting the supply of revenue vehicles will be vehicle operations and maintenance.

On the operations side, since new service initiatives are anticipated in the future, there will be an additional demand placed on the existing fleet. On the maintenance side, deferred maintenance, coupled with the absence of a major overhaul program and an aging bus fleet, can lead to more frequent breakdowns and in-serv-
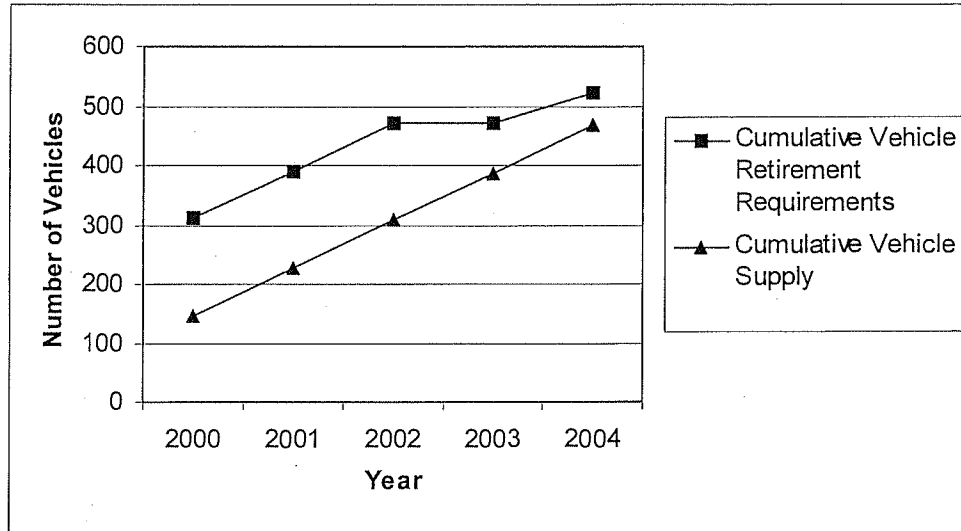
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Figure B-10: Vehicle Supply vs. Vehicle Retirement Requirements

Service	Total Active Fleet	Peak Vehicle Requirement	Average Daily Maintenance Demand	Operating Spares Ratio
Regular	787 Buses	656 buses	105 Buses	20%

Table B-7: Operating Spares Ratio

ice failures, requiring more spares.

B.7 SUPPLY/DEMAND COMPARISON: OPERATING SPARES RATIO

The supply of buses can be compared to the demand for vehicles using the Operating Spares Ratio. The standard calculation of an Operating Spares Ratio is as follows:

$$OSR = \frac{TAF - PVR}{PVR}$$

Where: OSR represents the Operating Spares Ratio

TAF represents the Total Active Fleet
PVR represents the Peak Vehicle Requirement, excluding vehicles nec essary for regular maintenance

Based on the standard definition of the Operating Spares Ratio (OSR), the core-bus system was calculated to have a 20 percent spares ratio during weekday, peak hour service as illustrated in Table B-7. However, two factors significantly affect the bus system and make the Operating Spares Ratio unacceptably low.

1. The calculation of the OSR does not include the daily demands of maintenance and inspection schedules, nor does it take into account the

effects of unscheduled and corrective mainte-
nance on the availability of vehicles. Given the
fact that approximately 355 buses need to be
pulled in daily for scheduled and unscheduled
maintenance requirements, the bus system can
experience a serious deficit during peak opera-
tions. Consequently, the MTA often has trouble
meeting its peak bus service requirements.

2. A second concern is the MTA's aging bus
fleet system; existing vehicle procurements are
not adequate to replace the entire component
of the fleet exceeding 12 years of age over the
next five years. Moreover, an aging fleet results
in more buses being pulled in for unscheduled
maintenance and more serious problems
detected during scheduled maintenance. This
significantly impacts revenue vehicle supply and
consequently, bus spare ratios.

B.8   CONCLUSIONS

In summary, although it is generally acknowl-
edged that right sizing the fleet actually
improves operations and lowers cost, for the
MTA, difficulties, such as an aging bus fleet,
fixed vehicle procurement and high daily main-
tenance demand, hinder achieving and main-
taining a 20 percent spare ratio as recommend-
ed by the FTA.

Appendix A:
Calculation of the Average
Daily Demand of Scheduled Maintenance

The following methodology was used to estimate the average daily demands of scheduled maintenance:

1. Calculate the number of times each maintenance and inspection cycle must be performed on a single vehicle in the course of a year.[2]

$$\text{\# cycles/year} = \frac{365 days/year}{\# days/cycle/vehicle}$$

Example: 45-Day Inspection:

$$\text{\# cycles/year} = \frac{365 days/year}{45 days/cycle/vehicle}$$

cycles/year = 8.1 cycles/year/vehicle

Therefore, one bus will require approximately eight, 45-Day inspections in the course of a year.

2. For each maintenance cycle, multiply the number of cycles per year by the number of vehicles to determine the total number of maintenance cycles which must be performed on the entire fleet in the course of a year.

Total # of maintenance cycles for the fleet = # of cycles/year x # vehicles

Example: 45-Day Inspection:

Total # of maintenance cycles for the fleet = 8.1 of cycles/year x 787 buses
Total # of maintenance cycles for the fleet = 6375 cycles/year

3. Divide the number of maintenance cycles for the fleet by the number of days in the year to determine the average daily maintenance demand of an inspection cycle.

Example: 45-Day Inspection:

Average Daily Maintenance Demand =

$$\frac{6375 cycles/year}{365 days/year}$$

Average Daily Maintenance Demand = 17.4 Inspections/day

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[2] For Brake Inspection and Major Inspection, maintenance is performed after every certain number of miles of operation. Thus, in these two cases, the average vehicle miles/bus/year were computed from the total annual vehicle miles for the entire system and based on the criterion, e.g. inspection carried out every 3000 miles, the # cycles/year was computed for each inspection.